Experiment 3: Digital Oscilloscope Familiarity

Objectives:
Today's experiment builds on any previous oscilloscope experiences you may have had. Digital oscilloscopes are popular today for a variety of good reasons, not the least of which is their ability to hold and display data associated with either a periodic or one-time event.

Pre Lab:
- Read and understand Hambley Section 5.1
- Determine the V_{Peak} and $V_{Peak\text{-}Peak}$ of a 120 V_{RMS} signal

Part A: Oscilloscope Functional Check

Procedure:
1. Open to page 5 of the TDS-210 User Manual (red cover), turn the scope **ON** (top left), and allow time for the self test to complete (about 5 seconds).

2. Connect a probe to CH-1 and make the test contacts described on page 5 of the user manual (we only will test CH-1 today).

3. Push **AUTOSET** button and validate the probe. If the square wave is imperfect, contact your lab instructor. Refer to page 6 of the user manual for information on probe compensation.

4. Select the **CH-1 Menu** button (left at center). A description of the display screen area is available on page 10 of the User Manual. Record on the Data Sheet the following data read from the bottom of the display screen:
   - CH-1 volts per division (Item 11)
   - Horizontal Time Base in seconds per division (Item 10)
   - Probe amplification (if not 10X, toggle until it is)
     Warning: Whenever using the probes, verify that the 10X magnification is selected.

5. Select the **MEASURE** button (top center) and toggle the upper submenu until **Source** = **CH-1** (submenus are vertically stacked). Toggle again for **Type** and record on the Data Sheet:
   - CH-1 Frequency
   - CH-1 Period
   - CH-1 Mean
   - CH-1 Pk-Pk
     Note: The CH-1 Pk-Pk value (VPP) provides the absolute difference between the maximum and minimum peaks of the entire waveform. This value is not necessarily representative of the steady state peak amplitude, so it should be interpreted sensibly.

6. Open the User Manual to page 20 so you follow along as you select the **ACQUIRE** button (top right), viewing the display in several modes using the submenu buttons. For each mode, note the effects of toggling **RUN/STOP** button (top right). Describe in your lab report your observations and the differences between the acquire modes: Sample, Peak Detect, Average, and Averages.

Part B: Waveform Generator

Procedure:

1. Power up the HP-33120A waveform generator.

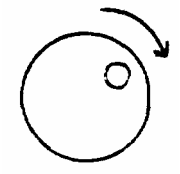
2. Develop experience setting the output frequency. Many options are available, such as:

   FREQ ~
   ENTER NUMBER 1500 ENTER ---> 1.500 kHz

   △△◁△△△ ---> 4.700 kHz

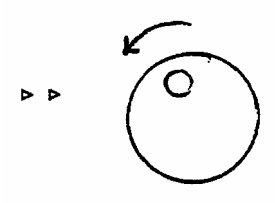
   Describe in your lab report the function of the arrow keys for this step.

3. Now rotate the knob a few clicks:



   ----> 7.700 kHz

   Try these combinations:



   ----> 7.670kHz

   ENTER NUMBER 10 △ ----> 10.000MHz

   ENTER NUMBER 10 ▽ ----> 10.000kHz

   Describe in your lab report the function of the arrow keys for this step.

   In the future, set frequencies as you best see fit.

4. Now practice setting output amplitudes.

   AMPL
   ENTER NUMBER 110 △ ----> MAX VALUE
   ----> 10 VPP or 20 VPP
   (either is acceptable)

   Explain in your lab report what happened?

   ENTER NUMBER 110 SHIFT ▽ ----> 110 mV RMS ~

   Describe in your lab report the effect SHIFT ▽ had on the units display?

5. Next select the square wave button, ⊓⊔ , followed by

   SHIFT ENTER ▷▷▷ ----> D: SYS MENU

   ▽▽▷ (as needed) ----> HIGH Z

   ENTER ----> EXITING

   NOTE: We should take this step whenever our circuit has an impedance exceeding several hundred Ohms.

6. Using any method, set:

   AMPL 200 mv PP ⊓⊔

   FREQ 1.100 kHz

Part C: Signal Measurements

Procedure:

1. For this part you will use the HP33120A waveform generator as an AC Voltage Source. Use any method described in Part B to set the HP33120A for a sinusoidal output ~ with amplitude 1.2 V_{RMS} and frequency of 60Hz. This signal is a scaled down representative of standard AC power available at most household outlets, which has an amplitude of 120 V_{RMS} at a frequency of 60Hz

2. Configure the Fluke 45 as an Ohmmeter and measure the resistance of the 1000Ω resistor. Record this value in the data sheet.

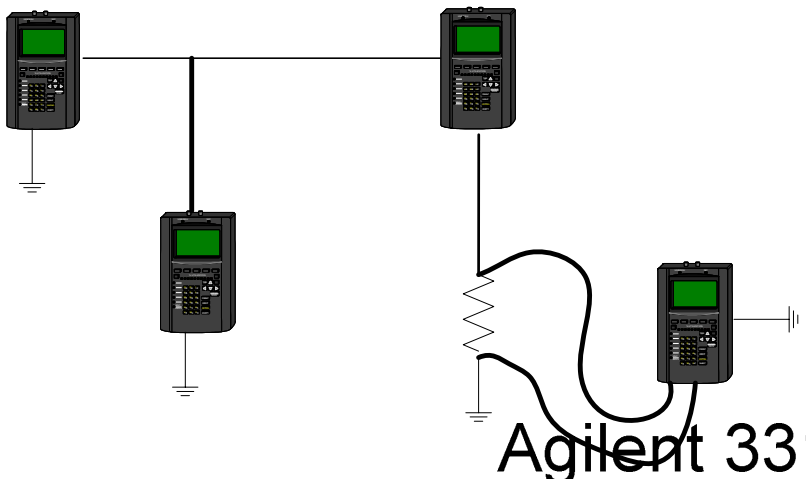
3. You will use the Fluke 45 as an AC Voltmeter by pushing the V~ button. All readings will now be in $V_{RMS.}$

4. Configure the Keithley multimeter as an AC Ammeter by pushing the ACI button in and set the meter to Auto Range.

5. Construct the circuit described by Figure 1. Do Not connect the positive lead of the HP33120A until you have verified the other circuit connections are wired correctly. Make certain that the Ammeter is connected in SERIES and the Voltmeter is connected in PARALLEL. Note the common ground connection is simply one conductive path referenced at zero volts. Use banana leads to connect the components, but X10 probes to measure the voltage directly across the 1000Ω resistor. In connecting the probes, use common sense precautions to avoid breaking the delicate arms. Alligator clips from probes must be connected to the common ground.

6. Record values on the data sheet for AC Volts and AC Current measured with the multimeters.

Figure 1



7. Push AUTOSET to generate a display. If the display is excessively noisy, the problem is usually sloppy leads, so try to remedy these first. If changing leads doesn't correct a problem, ask for help. Verify you are using X10 probe settings (CHANNEL MENU buttons). Experiment with the volts per division and seconds per division knobs on the oscilloscope to properly display the voltage waveform. Adjust the waveform position using the position knobs. Record values on the data sheet for the CH1 volts per division and seconds per division.

8. Push the MEASURE button of the oscilloscope and repeatedly the CH1 softkey. Record measured values on the data sheet values for Frequency, Period, V_{Mean}, V_{P-P}, and V_{RMS}. Describe in your lab report your observations and comment on whether these values agree with what is expected.

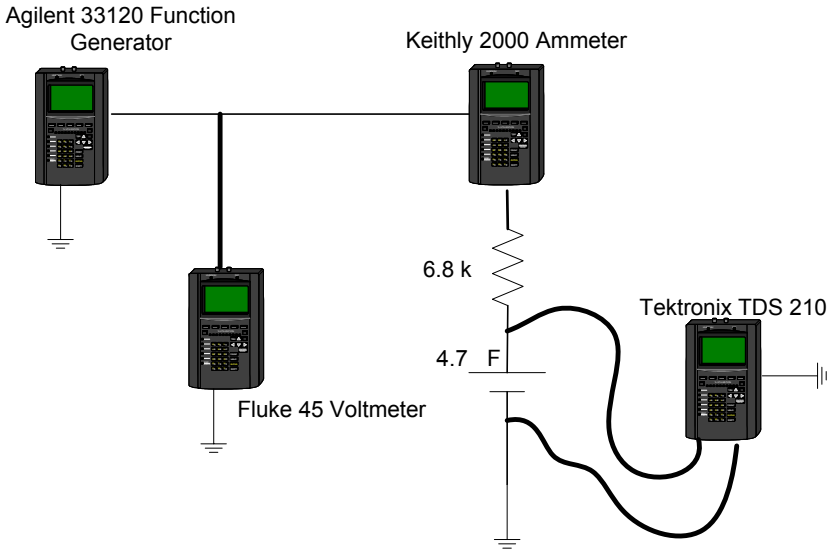
9. Reconfigure the circuit as shown in Figure 2 by replacing the 1000Ω resistor with a 4.7μF capacitor in series with a 6.8KΩ resistor. Connect the X10 CH1 Probe to the Ammeter side of the 6.8KΩ resistor and the the X10 CH2 Probe to the 4.7μF capacitor. Both alligator clips of the X10 probes should be connected to the ground side of the 4.7μF capacitor.

10. Push AUTOSET to generate a display. If the display is excessively noisy, the problem is usually sloppy leads, so try to remedy these first. If changing leads doesn't correct a problem, ask for help. Verify both channels are using X10 probe settings (CHANNEL MENU buttons). Experiment with the volts per division and seconds per division knobs on the oscilloscope to properly display the voltage waveform.

11. Go to the PC and start the WaveStar Application. This Program allows you to acquire the display of the digital oscilloscope. Print your display and include it with your lab report. Describe in your lab report your observations and comment on whether these values agree with what is expected. What are the observed phase angle and frequency differences between CH1 and CH2?

12. Ask your lab instructor to verify your results. Then disconnect your equipment and neatly return items to their original locations.

Figure 2


Agilent 33120 Function Generator
Keithly 2000 Ammeter
6.8 k
Tektronix TDS 210
4.7 F
Fluke 45 Voltmeter

Data Sheet

Prelab:

V_{Peak} _____ $V_{Peak-Peak}$_____

Part A: Oscilloscope Functional Check

CH-1 volts per division _____

Horizontal seconds per division _____

Probe amplification _____ (if not 10X, toggle until it is).

CH-1 Frequency _____ CH-1 Period _____

CH-1 Mean _____ CH-1 P-P _____

Part C: Signal Measurements

Measured Resistance _____

Measured Voltage _____ Measured Current _____

Frequency _____ Period_____

V_{Mean} _____ V_{P-P} _____

V_{RMS} _____

Your Name_____

Partner Name_____

Lab Instructor_____ Date_____

Discussion guide for Experiment 3

Part A:

Proc. 6: Describe your observations and compare the difference between the acquire modes:

Sample:

Peak Detect:

Average:

Averages:

Part B:

Proc. 2, 3: Describe the function of the arrow keys when seting the output frequency.

∧,∨ :_____ <, >:_____

Proc. 4: Show the result when setting the output amplitudes using the following keys, and explain why.

Enter number 110 ∧ :_____ why?_____

Enter number 110 shift ∧ :_____ Enter number 110 shift ∨ :_____

Describe the effect SHIFT had on the units display. _____

Enter number 110 ∨ , explain why the result is 7.07/3.53 VRMS?_____

Part C:

Proc. 7: Record values for the CH1 volts per division and seconds per division.

volt/div:_____ sec/div:_____

Proc.8: Describe your observations and comment on whether these values agree with what you expected.

Proc. 11: **Print** the display acquired from the oscilloscope. Describe your observations and comment on whether these values agree with what you expected.

Phase angle difference between CH1 and CH2:_____

Frequency difference between CH1 and CH2:_____

Comments: